## First Year First Semester

### Hum/T/A HUMANITIES-A

English - 2 Pds/week - 50 Marks
Sociology - 2 Pds/week - 50 Marks

HUMANITIES

1.Basic writing skills
2.Report, Covering Letter & Curriculum-Vitae writing
3.Reading and Comprehension
4.Selected Short Stories

Text Book: ENGLISH FOR ALL

SOCIOLOGY

1.Sociology: Nature and scope of Sociology - Sociology and other Social Sciences - Sociological Perspectives and explanation of Social issues
2. Society and Technology: Impact of Technology on the Society - A case study
3. Social Stratification: Systems of Social Stratification - determinants of Social Stratification - Functionalist, Conflict and Elitist perspectives on Social Stratification
4.Work: Meaning and experience of work: Postindustrial society- Post-Fordism and the Flexible Firm
5.Development - Conceptions of and approaches to development - The Roles of State and the Market in the Development
6. Globalization: The concept of globalization - globalization and the nation state - Development and globalization in post colonial times.
7. Industrial Policy and Technological change in India - The nature and Role of the State in India
8. Technology Transfer: The Concept and Types of Technology Transfer-Dynamics of Technology Transfer
9. Technology Assessment: The Concept - Steps involved in Technology Assessment
10. Environment: Sociological Perspectives on Environment - Environmental Tradition and values in ancient India
11.The Development of Management: Scientific Management - Organic Organization - Net Work organization - Post modern Organization - Debureaucratization - Transformation of Management
12. Technological Problems and the Modern Society: Selected Case Studies - Electric Power Crisis, Industrial and/or Environmental Disaster, or Nuclear Accident.

### ME/Math/T/112 MATHEMATICS-IM

Function of a Single Variable: successive differentiation. Rolle’s theorem. Mean value theorems. Taylor’s theorem and Mclaurin’s series. Maxima and minima, inditerminate forms. Tangent, normal and curvature.

Functions of Several Variables: Limit and continuity. Partial derivatives. Differentials. Partial Derivatives of a composite function. Implicit function. Jacobian. Taylor's theorem. Maxima and minima. Lagrange's method.
Reimann Integration: Definition, Properties. Fundamental theorem of integral calculus. Improper integrals. Gamma and Beta function.
Multiple Integrals: Existence of integrals (Statement only). Properties of double integral. Evaluation of double integral. Change of order of integration and change of variables.

## ME/Math/T/113 MATHEMATICS-IIM

Determinants: Definition and properties, Solution of a system of linear equations by Cramer's rule.
Matrices: Definition, algebra of matrices, inverse of a matrix, solution of a system of linear equations by matrix method, row and column operations, rank of a matrix, eigenvalues and eigenvectors, characteristic polynomial of a matrix, Cayley – Hamilton theorem and application.
Complex numbers: Definition, properties, geometrical representation, Argand's diagram, DeMoivre's theorem and its application, exponential and trigonometric functions of a complex variable, exponential values of sine and cosine, logarithm of a complex number. Inverse circular and hyperbolic functions, Gzregory's series.
Ordinary Differential Equations: First order exact and linear equations, second order linear equations with constant coefficients. Euler-Cauchy equations, ordinary point and regular singularity of a second order differential equation, series solution, Bessel functions, Legendre polynomials, Strum-Liouville problem.

## ETech/EE/T/1 ELECTRICAL TECHNOLOGY-I

DC Circuits: Kirchhoff's Laws. Maxwell's Loop Current Methods of Analysis. Star-Delta Conversion. Superposition Theorem. Thevenin's Theorem. Maximum Power Transfer.
Magnetic Circuit: MMF, Flux ,Reluctance. B-H Loop. Hysteresis and Eddy current loss. Magnetic circuit analysis with air gap.
AC 1 -phase: Periodic Waves and Sinusoids. Average and RMS Values, Form Factor, Peak. Factor. Phasor concept of Sinusoids. Impedance and Admittance. Power, Power Factor, V A, V AR. Series R-L-C Circuit ,Parallel R-L-C circuit. Resonance.
Balanced 3-phase: 3-phase AC balanced circuits. Phase-sequence. Star and Delta connections. Power, V A, V AR, Power Factor _or balanced 3-phase circuits.
Power Measurement: Wattmeter circuit connection. Power Measurment by two wattmeter methods in 3phase system.
DC Machines: Construction and general priciple of operation. Generator EMF Equation. Field connection ,shunt series and compound. Generator characteristics.
Motor-equation and general operation. starting and speed control, torque -speed curve.
1-PhaseTransformer: Construction. EMF equation. Phasor diagram. Equivalent circuits. Losses and Efficiency. Open circuit and Short circuit test.
3-Phase Induction Machine: Types of induction machines. Rotating magnetic field, slip ,torque equation, torquespeed curve.DOL starting and reduced voltage starting.
3-Phase Synchronous Machines: Alternator, constructional features, EMF equation,

synchronous reactance, power -angle characteristics.
Concept of synchronous motor.
Meters: DC and AC Ammeters and Voltmeters. Megger.Multiplier.

Books :
1 Electrical Science by Prof. S. Chowdhury, Prof. R. Chakraborty & Prof. P. K. Chatterjee.
2 Electrical Machines by Prof. P.K. Mukherjee & Prof. S. Chakravorti.

## ME/T/115 ENGINEERING MECHANICS-I

Introduction to vector algebra, concept of free body diagram, laws of Coulomb's friction, equilibrium of rigid bodies, principle of virtual work, application of frictions in machines, properties of surfaces, centre of mass and centre of gravity, shear force and bending moment diagrams.
Introduction to elasticity, problems in uni-axial stress field.

## Ph/T/1C PHYSICS-IC

1. Potential and intensity and their relation - gravitational and electrostatic examples, States of equilibrium, Work and Energy, Conservation of energy,
2. Surface tension, excess pressure inside a soap bubble, capillary rise- Jurin's law. Bernoulli's theorem and its applications.
3. Lens system (combination of thin lenses), eyepieces, microscope,
4. Nature of light waves, Interference of light waves, Young's experiment, Spatial and temporal coherence, Fresnel bi-prism, Interference in thin film, Newton's rings, Measurement of film thickness and wavelength, Diffraction of light waves, Huygen's construction, Fresnel and Fraunhoffer diffraction, Fraunhoffer diffraction due to single slit and plane diffraction grating, Polarisation of light waves, Polarisation by reflection, Brewster's law, Double refraction- ordinary extraordinary rays, Polaroid.
5. Macroscopic and microscopic description, Thermal equilibrium, Zeroth law of thermodynamics, Concept of international practical temperture scale, Heat and Work, First law of thermodymamics and some applications, Reversible and irreversible processes, Carnot cycle, Second law of thermodymamics, Concept of entropy, Thermodynamic relations.
6. Electric potential and intensity, Flux of electric field, Gauss's law and its application to problems with spherical and cylindrical symmetry, Capacitance- parallel plate and spherical condensers. Biot-Savart law and Ampere's law in magnetostatics, Calculation of magnetic field in simple situations like (i) straight wire (ii) circular wire (at a point on the symmetry axis) and (iii) Solenoid, Time-varying fields, Faraday's law of electromagnetic induction, Self and mutual inductance.
7. Energy levels of the hydrogen atom and the Bohr atom model, X-ray spectra, X-ray diffraction, Bragg's law, Compton effect. De-Broglie waves, Particle diffraction, Uncertainty principle and its application.

## ME/S/111 COMPUTER AIDED DRAFTING- I

Introduction to a Computer Aided Drafting software, basic commands of 2D drafting, dimensioning, concept of layer, view ports, layouts, modelspace, paperspace. Introduction drawing database, blocks, attributes, accessing internal & external database files, isometric drawing using isoplanes. Assignments. (Mode: Computer Terminal)

**ME/S/112 ENGINEERING DRAWING**

Drawing primitives: Instruments, letters, lines, title block etc., Geometric curves and shapes, concept of scale & dimension, projection – Orthographic & Isometric, Auxiliary View (Mode: drawing board)

**ME/S/113 WORKSHOP PRACTICE-I (Carpentry And Pattern Making)**

Introduction to types of Indian woods used for engineering purposes and carpenter's tools; use of wood working machines; making of selected joinery;
Introduction to different phenomena arising out of shrinkage of castings and pattern maker's rule; making of wooden patterns from supplied drawings and samples of patterns; making of core boxes.

## First Year Second Semester

**ME/Math/T/121 MATHEMATICS-IIIM**

Sequence and Infinite Series: Concept of convergence, Cauchy's general principle (statement only), comparison test, D'Alembert's ratio test, Cauchy's root test.
Laplace Transform: Definition and properties, inverse transform, convolution, application to solution of linear differential equations with constant coefficients.
Probability and Statistics: Collection and classification of data, graphical representation, measures of central tendency and measures of dispersion, correlation and regression, regression equation, classical definition of probability, laws of probability, expectation, probability distribution error function, sampling.

**ME/Math/T/122 MATHEMATICS-IVM**

Fourier Series: periodic functions, trigonometric series of sines and cosines, Euler formulae, Fourier series in the interval $(-\pi, \pi)$, Dirichlet's conditions, even and odd functions, half range sine and cosine series, Fourier series in the intervals $(0, 2\pi)$, (-i,i), (0,i) etc.
Partial Differential Equations: first order partial differential equation, geometrical interpretation, second order partial differential equations with constant coefficients and their classification into elliptical, parabolic and hyperbolic type, solution of one dimensional wave and diffusion equations and Laplace equation of dimension two by the method of separation of variables.

**ME/ET/T/123 ELECTRONICS**

Semiconductors- energy band structure, intrinsic and extrinsic semiconductors, N & P type semiconductors; P-N junction and its V-I characteristics, rectifiers and filters, voltage regulator; transistors (DJT & FET) and their characteristics, application of transistors as amplifiers, biasing technique and small signal analysis technique in connection with transistor circuits; practical transistor amplifiers, effects of feedback in input impedance and gain of an amplifier; differential amplifier, operational amplifier as an integrated building block; application of operational amplifiers- integrator, differentiator, adder etc., active filters, oscillators; large signal application of transistor power amplifiers; switching characteristics of transistors and its application in logic circuits, multivibrators; digital logic-combinational circuits, gates, adder, subtractor, multiplexor, decodes etc. sequential circuits, flip-flop & counters.

## ETech/EE/T/2 ELECTRICAL TECHNOLOGY-II

Structure of power system-generation, transmission and distribution subsystems, necessity of different voltage levels, advantage of high voltage transmission, comparison between d.c. and a.c. transmission, different types of substations, equipments used in substations.
Types of power plants (thermal, hydro, nuclear and gas turbine)- a brief introduction. Combined operation of different types of power plants- load curve, base and peak load, selection of plants, advantages of combined operation, plant load factor and capacity factor, simple problems related to plant load factor and capacity factor. Overhead and underground transmission, comparison between them. Different types of distributors- single end fed, both end fed and ring main, problems on d.c. distributors.
Single-phase Induction Motors
Split phase induction motor, Capacitor start induction run motor with centrifugal switch. Shaded pole type motor. Operating principles and operating characteristics of each type. Basic principle and operating characteristics of the I-phase ac commutator motor.
Electric Drives
Drive specifications, Four quadrant representation. Starting and speed control methods of DC and AC motors, including basics of power electronic control. Accelerating time. Effect of fly wheels. Methods of braking in drives.
Electric Heating, Traction & Apparatus
Electric Heating: Basic advantages, classification of ovens & furnaces, Industrial application areas. Basic principles of Resistance Furnaces, Arc Furnaces, Induction Furnaces and Dielectric Heating.
Electro-plating, Extraction & refining of metals.
Electric Welding: Principles and Equipment
Storage Batteries: Common types and their characteristics. Principles of charging and modes e.g. float, boost, etc.
Electric Traction: General introduction and requirements. DC and DC traction supplies. Current collectors, Traction Motors.
Basic concepts of lighting quantities:
Visible electromagnetic radiation, relative spectral sensitivity of the eye, spectral power distribution of lamps, luminous flux, luminous intensity, luminance, Illuminance- Horizontal & Vertical, Luxmeter

Lamps and accessories:
Incandescent lamp, Tungsten halogen lamp, Fluorescent tubular lamp, energy saving compact fluorescent lamp, low and high pressure sodium lamp, high pressure mercury vapour lamp, blended lamp, metal halide lamp, light emitting diode - very brief description of these lamps, main features of their operational characteristics and application areas.
Starters / Igniters, Magnetic / Electronic ballast, capacitors and lamp holders.
Domestic wiring :
Electrical wiring guidelines, wiring methods, protection, earthing system.

## ME/T/125 STRENGTH OF MATERIALS

Thin pressure vessels, torsion of circular shafts, close-coiled helical springs, stresses in beams due to bending and shear, compound beams, general case of plane stress, Mohr's circle for stress and strains, strain rosettes, deflection of beams, combined bending and torsion, concept of elastic stability with particular reference to buckling and columns.

## ME/T/126 THERMODYNAMICS-I

1. Introduction: Microscopic and Macroscopic viewpoints in thermodynamics. Fundamental concepts of System, Control volume, State, Property, Equilibrium, Processes etc.
2. The Zeroth law of thermodynamics: Thermal equilibrium. Temperature. Principle of thermometry. International practical temperature scale.
3. Energy: Different energy forms-stored energy, energies in transition. Definitions.
4. Properties of pure substances: Thermodynamics properties of pure substances in solid, liquid and vapour phases. P-V-T behaviour simple compressible substances. Phase rule. State postulate. Thermodynamic property tables and charts. Ideal and Real gases. Equations of state. Compressibility factor. Generalised compressibility chart. Problems.
5. The First law of thermodynamics: The first law of thermodynamics for systems. Corollaries. Internal energy and enthalpy. First law for control volumes. Steady state and unsteady state applications. Process calculations for ideal and real gases using equations, tables and charts. Problems.
6. The Second law of thermodynamics: Limitations of the first law of thermodynamics. Steadily operating systems-Heat engine, Heat Pump and refrigerator. Thermal efficiency. Coefficient of Performance. Carnot cycle. Statements of the second law of thermodynamics. Equivalence of Kelvin Planck and Clausius statements of the second law of thermodynamics. Corillaries. Entropy. Reversibility and Irreversibility. Problems Mollier Chart and its use-Measurement of dryness fraction, Nozzle expansion etc. Second law analysis of control volume. Entropy generation. Reversible work. Availability. Irreversibility. Problems.
7. Thermodynamic relationships: Tds relations. Maxwell equations. Clapeyron equation, Clausius Clapeyron equation. Joule-Thompson coefficient. Compressibility and expansion coefficient. Problems. Development of property data in graphical and tabular form.

**Ph/S/2 PHYSICS LABORATORY**

(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection method.
2. Determination of Galvanometer resistance by Thomson's method.
3. To find high resistance by Galvanometer deflection method.
4. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
5. To compare to low resistance by drop of potential method.
6. To determine resistance per unit length of wire by using Carey Foster bridge.
7. To estimate strength of a current by using copper voltmeter.
8. a) To compare the EMF's of two cells by using a potentiometer
b) To measure current by using a potentiometer
9. To measure the horizontal components of earth's magnetic field intensity using deflection and vibrating magnetometers.
10. Determination of co efficient of linear expansion by optical lever method.
11. Determination thermal conductivity of metal by Searle's method.
12. To determine co-efficient of viscosity by Capillary flow method.
13. Determination of Young's modulus by Flexure method.
14. To draw mutual and anode characteristics of triode and hence too fine Rp, μ, and gm
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and hence to find hi, hf
16. Determination of refractive index of the material of the glass prism by prism spectrometer (for at least two ?s)
17. Study of collisions in one dimension using a linear air track
18. Use of an air track for obtaining potential energy curves for magnetic interactions.
19. Study of oscillations under potential wells of various shapes using an air track.
20. Experiments on diffraction in single slit, double slit and plane grating using He- Ne laser
a) To find the wavelength of a monochromatic light by single slit.
b) To find slit separation of a double slit.
c) To find number of rulings per cm of a plane grating
21. To find the wavelength of a monochromatic light by Newton rings.
22. Fabry-Perot interferometry: To find out separation of wavelength of sodium D1 & D2 lines.

**ME/S/122 DESCRIPTIVE GEOMETRY**

Projection of points, lines. Types of lines and their projections. Concept of true length, true length of oblique lines: auxiliary view & revolution method, parallel & perpendicular lines, concept of traces lines & planes. Intersection & development of surfaces: Prisms, pyramids, cylinders, cones, spheres.
(Mode: drawing board)

**ME/S/123 MACHINE DRAWING-I**

Thread profile, nuts & bolts, stud, riveted joint, welded joint, hooks/cotter/knuckle joint, pulley, shaft coupling (rigid/flexible), stuffing box. (Mode: Computer Terminal)

### ME/S/124 WORKSHOP PRACTICE-II (Fitting and Welding)

Introduction to fitter's tools, gauges, measuring instruments etc.; marking of jobs; fitter's job involving chipping, filing, sawing, drilling; use of taps and dies; pipe fittings and plumbing.
Introduction to and practice of different welding processes- gas, SMAW, TIG, MIG, SAW, resistance welding etc.; introduction to gas cutting and its application; soldering, brazing etc.; making welded joints using different welding processes.

## Second Year First Semester

### ME/Math/T/211 MATHEMATICS-VM

Vector Calculus: Scalar and vector products, differentiation of a vector point function, tangent and normal vectors, directional derivative, gradient, divergence and curl, important identities, Green's, Gauss' and Stokes' theorem and applications.
Linear spaces: Definition, linear dependence and independence of vectors, basis and dimension, norm linear space, inner product space, orthogonal vectors, linear transformations.

### ME/T/212 FLUID MECHANICS-I

Definition of fluid, continuum hypothesis, different properties of fluid, classification (like Newtonian/non-Newtonian, ideal/real etc.).
Fluid Statics: pressure at a point, Pascal's law, variation of pressure within a static fluid – equation of hydrostatic pressure distribution, variation of properties in static atmosphere; measurement of pressure; hydrostatic thrust on plane and curved surfaces; buoyancy, stability of submerged and floating bodies.
Fluid Kinematics: preliminaries of Eulerian and Lagrangian description of fluid flow; velocity and acceleration of fluid particles in rectilinear and curvilinear co-ordinates; different types of flow – steady and unsteady flow, uniform and non-uniform flow, one-two and three dimensional flow, rotational and irrotational flow, laminar and turbulent flow; stream line, streak line and path line; stream filament anf stream tube; principle of conservation of mass – equation of continuity for a stream tube and for unsteady three dimensional flow; deformation of a fluid particle – linear and angular deformation and rotation; vortex motion; relative equilibrium of fluids.
Fluid Dynamics: principle of conservation of linear momentum, Euler's equation of motion along a stream line and for unsteady three dimensional flow; derivation of Bernoulli's equation and physical significance of different terms; applications of Bernoulli's equation in flow measurement devices: stagnation tube, pitot tube, venturi meter, orifice meter, triangular and rectangular weir.

Application of Linear Momentum to Control Volume: linear momentum equation; analysis of force exerted by a fluid stream on a solid boundary – jet impingement, thrust on pipe bends etc.
Principle of Conservation of Angular Momentum and its application.
Steady Flow Energy Equation and its application.
Characteristics of Laminar and Turbulent Flow: Reynolds experiment, critical Reynolds number; laminar flow through pipe – Hagen Poiseuille equation.
Flow Through Closed Conduits: Darcy Weisbach equation, friction factor of closed conduits, flow through non-circular ducts, Moody's diagram and its use; minor losses – at sudden expansion, at sudden contraction, at bends, at valves and fittings etc; analysis of simple pipe network problems.
Free Surface Flow: flow in open channel, Chezy's equation, Manning's equation, economical cross section, specific energy, hydraulic jump.

## ME/T/213 ENGINEERING MECHANICS-II

PART-I (MARKS: 50), (2-0-0)

Thin-walled beams, asymmetric bending, energy principles, Castingliano's theorems, curved beams, thick-walled cylinders under radial pressures and rotating wheels, Lame's equation, theories of failure, introduction to the theory of plates.

PART-II (MARKS: 50), (2-0-0)

Rectilinear motion, elements of vector calculus, introduction to curvilinear motion, kinematics of particles in different co-ordinate systems, kinetics of particles-equation of motion, D'Alembarts principle, work-energy principle, momentum principle, central force motion, introduction to system of particles.

## ME/T/214 THERMODYNAMICS-II

1. Vapour Power Cycles: Carnot cycle, Rankine cycle, Reheat cycle, Regenarative cycles with open and closed Feed Water Heaters. Availability analysis of cycles.
2. Gas Power Cycles: Air Standard Cycles – Otto, Diesel, Dual, Stirling, Brayton cylces; Gas turbine cycles with intercooling, reheating and regeneration. Use of air tables for gas power cycle analysis.
3. Refrigeration Cycles: Vapour Compression Refrigeration cycles, Vapour Absorption Refrigeration cycles, P-h Chart, Air Refrigeration cycle.
4. Cogeneration and Combined Cycles: Binary vapour cycle, Cogenerative cycles, Combined Gas Vapour cycles.
5. Thermodynamics of Mixtures: Mixture of ideal gases, Mixture of ideal gas and vapour, Laws of thermodynamics for gas-vapour mixtures, Psychrometry, Thermodynamic analysis of psychrometric processes, Thermodynamic relations for multi-component systems.
6. Fuels and Combustion: Fuels, Air requirements, Analysis of Combustion products, enthalpy of formation, Calculation of enthalpy of combustion and adiabatic

flame temperature, HHV and LHV of fuels, Second law analysis of chemically reacting systems, Fuel cells.

7. Chemical and Phase Equilibrium: Criteria for equilibrium, Equilibrium between multi-component and multi-phase systems, Gibbs phase rule, Metastable equilibrium, Chemical equilibrium, Determination of equilibrium composition and equilibrium temperature in chemically reacting systems. Ionization.

## ME/T/215 MANUFACTURING PROCESSES

Introduction to manufacturing Processes;.

Casting- The basic idea, patterns, moulding materials - properties and mould making; various casting processes; cores, gating and risering; foundry furnaces; special casting methods; casting defects, inspection and repair.

Forming- hot and cold working; rolling; forging and forging dies; drawing, deep drawing; extrusion; bending; coining, hubbing, embossing, thread rolling, tube piercing etc; HERF processes; press working etc.; Defects in metal working.

Welding and joining processes- classifications; gas welding; flame cutting; arc welding- electric arc welding -theory of heat generation, power source selection, arc structure, arc characteristic; metal transfer in arc welding; different are welding processes- SMAW, Carbon Arc Welding, Atomic Hydrogen Welding, MIG, TIG, $CO_2$- MIG, FCAW; other welding processes like ESW, EBW, PAW, USW, Explosion Welding etc.; welding consumables; characteristics of weldment; welding defects and inspection; welding of non-traditional materials; Introduction to newer processes of welding; soldering and brazing.

## ME/T/216 KINEMATICS OF MACHINES

Review of velocity analysis (resolution & composition, instantaneous axis and relative velocity methods) and acceleration analysis (graphical & analytical methods), Kennedy's theorem, analytical treatment by using complex notation, Lagrangian co-ordinates.

Linkage: 4-bar linkage, space linkage, Freudenstein equation, crank & rocker mechanism, drag link mechanism, non-parallel crank linkage, automobile steering mechanism, slider-crank mechanism, swinging block mechanism, oscillating arm quick return mechanism, icicles linkage, elliptic trammel, toggle mechanism, straight line mechanism, pantograph, universal joint, etc.

Transmission of motion by direct contact: pitch point, angle of action, pressure angle, conjugate curves.

Bodies in pure rolling contact.

Cam & follower: plate cam, cylindrical cam – displacement, velocity & acceleration diagram, analytical treatment in the design of different types of cams.

Gears: Law governing profile of gear tooth, analysis of tooth profile foe circular and non-circular gears for fixed centre distance, interference, minimum no. of teeth, gear tooth of involute & cycloid profile, spur gear, bevel gear, rack & pinion, worm gear.

Gear train: differential gear train, epicyclic gear train, bevel gear differential of automobile.

Belt drive: open & cross belt, quarter twist belt, stepped pulley, equal stepped pulley, guide pulley, crowning of pulley.
Chain drive. Differential screw, Compound screw.
Geneva wheel mechanism, intermittent motion from continuous motion.

### ME/EE/S/211 ELECTRICAL TECHNOLOGY LABORATORY- I

To supplement the course on 'Electrical Technology – I'.

### ME/S/212 COMPUTER AIDED DRAFTING- II

Introduction to AutoLISP & Visual LISP, AutoLISP operators, generation of loop, file handling, entity handling, creation of dialogue box, 2D drawing, 3D modeling. (Mode: Computer Terminal)

### ME/S/213 MACHINE DRAWING- II

Plummer Block, Valve: Steam stop, Safety/Relief/Non-return, Tool head of shaping machine, IC Engine piston assembly/Engine parts. (Mode: Computer Terminal).

### ME/S/214 WORKSHOP PRACTICE-III (Forging and Moulding)

Forging: Introduction to forging tools, furnaces and forging machines; to practice basic forging operations- drawing out, upsetting, necking etc.; introduction to forge welding. Introduction to moulding practice – preparation of moulding sand and use of moulder's tools; making of moulds by using selected pattern's; introduction to melting and pouring practice; experiments sand testing like permeability, moisture content, shutter index, mould strength, grain fineness number etc.; demonstration of injection moulding machine.

## Second Year Second Semester

### ME/T/221 MECHANICAL MEASUREMENTS AND INSTRUMENTATION

Static Performance Characteristics: error source, methods of elimination or reduction of error, sensitivity, linearity, resolution etc. of instruments.
Dynamic Performance Characteristics: zero, first and second order instruments.
Signal Conditioners: bridge circuit, amplifiers, filters etc.
Measurement: displacement, velocity, acceleration, force, torque, pressure, flow, strain, frequency, temperature, level etc.

### ME/T/222 FLUID MECHANICS-II

Basic concept of turbulence and turbulent flow.
Equation of motion for viscous flow – two-dimensional laminar flow between flat parallel plates and annulus.

Boundary Layer Theory: concept of boundary layer, boundary layer thickness, displacement thickness, momentum thickness, growth of boundary layer; Prandtl's boundary layer equations, Von Karman's momentum integral equation for a boundary layer, skin friction drag coefficient for laminar and turbulent boundary layer, hydraulically smooth and rough surfaces; boundary layer in pipe flow, friction velocity; separation of boundary layer, form drag, method of drag reduction; lift and drag on submerged bodies, aerofoils, stalling of aerofoils.
Compressible Flow: review of thermodynamic principles for perfect gases, adiabatic and isentropic relations; steady flow energy equation; speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, mach cone and Mach wave; isentropic flow, stagnation properties of a compressible flow, isentropic pressure, temperature and density ratios; compressibility correction factor in the measurement of air speed; area – velocity relationship for compressible flow through a variable area duct, mass flow rate through a duct, critical condition and choking; flow through convergent-divergent nozzle, over expansion and under expansion, performance of propulsive nozzles; normal shock, normal shock relations, wave drag.
Ideal Fluid Flow: rotation of a fluid particle, vorticity, rotational and irrotational motion; velocity potential function, circulation, stream function, flownet; governing equation for two dimensional irrotational motion, simple two dimensional irrotational flows like uniform flow, plane source, plane sink etc; superimposition of simple irrotational flows, combination of a source and a sink, combination of uniform flow and a source (Rankine half body), combination of a uniform flow and a source-sink pair (Rankine oval), doublet and its strength, superimposition of an uniform flow and a doublet (flow past a stationary cylinder); vortex motion – free and forced vortex, strength of a vortex; combination of a uniform flow, a doublet and a free vortex (flow over a rotating cylinder), Magnus effect, Kutta-Joukowski's theorem.
Dimensional analysis and Buckingham Pi theorem; similarity and model studies.
Unsteady flow – water hammer.

## ME/T/223 DYNAMICS OF RIGID BODIES

Revision of dynamics of system of particles as prelude to dynamics of rigid bodies.
Kinematics of Rigid Bodies:
Degrees of freedom of a rigid body. Types of motion of a rigid body – translation, fixed axis-rotation, rotation about a point and Euler's angle, plane motion, parallel plane motion, space motion. Relative motion method for general kinematic analysis of a rigid body. Analysis of plane motion using methods like absolute motion method etc.
Inertia tensor – definition, properties & transformation.
Kinetics of Rigid Bodies:
Deduction of general equation of motion from linear and angular momentum principles – Euler's equation Study of special cases of fixed axis-rotation of bodies of various shapes, parallel plane motion – application to study of rotating balancing, plane motion & alternative forms of equation – application to the force analysis of mechanisms, rotation about a point & Euler's equation in terms of Euler's angles- application to the motion of a top, gyroscopic motion.

Energy methods for rigid bodies & application to various types of motion of rigid bodies, Acceleration from work-energy equation – Virtual work and application to plane motion Impulse-momentum equation for rigid bodies & conservation of momentum methods in plane motion, Impulsive forces & torques – eccentric impact.

## ME/T/224 HEAT TRANSFER

1. Introduction: Modes of heat transfer
2. Conduction: Fourier law of heat conduction for isotropic material. Thermal conductivity. Derivation of general heat conduction equation. Non-dimensionalisation-thermal diffusivity and Fourier number, Types of boundary conditions.
Solution of steady one dimensional conduction problem with and without heat generation. Analogy with electrical circuits. Critical thickness of insulation.
Fins-rectangular and pin fins. Fin effectiveness and efficiency. Lumped parameter approach and significance of time constant. Biot number. Solution of steady two-dimensional conduction equation without generation using product solution.
3. Radiation: Physical mechanism of thermal radiation.
Laws of radiation, definition of black body, emissive power, radiation intensity,reflectivity, transmissivity, irradiation, radiosity.Radiation exchange between black bodies
Concept of grey-diffuse-isotropic (GDI) surface. Exchange between GDI surfaces by radiation network and matrix method. Radiation shielding.
4. Convection: Introduction. Newton's law of cooling and significance of heat transfer coefficient. Momentum and energy equation in two-dimensions. Non-dimensionalisation and significance of non-dimensional quantities. Order of magnitude analysis for flow over flat-plate. Velocity and thermal boundary layer thickness by integral method.
Natural convection-effect of coupling on the conservation equation. One-dimensional solution for Couette and Poiseulli flow.Concept of developing and developed flow.
Concept and correlations-forced convection for external and internal flows, Natural convection over a vertical flat-plate
5. Heat exchangers: Types of heat exchangers.
Introduction to LMTD. Correction factor. Fouling factor
Effectiveness-NTU method for heat exchangers, rating and sizing.

## ME/T/225 ADVANCED KINEMATICS AND ROBOTICS

1. Review of Kinematic analysis.
2. Syntheses: movability of linkages, degree of freedom, type & number syntheses, different methods of syntheses, (Freudenstein equation, Chebysev spacing method, approximate syntheses, complex variable technique), coupler curve syntheses- 5 accuracy points.
3. Dynamic modeling of planar mechanisms.
4. Robotics: robot definition, robotics systems and its role in automation, robot anatomy, robot classification & specifications, robot kinematics: forward & reverse transformations, homogeneous transformations, robot actuation & control, robot sensors:

contact & non-contact type, robot end effectors, mechanical, magnetic & pneumatic grippers.

## ME/T/226 MACHINE DESIGN-I

1. Review of common engineering materials and their properties, Stress – strain diagram, Improvement of properties through heat treatment and alloying
2. Introduction to design, factor of safety, modes of failure, stress concentration, endurance diagram and design criteria, manufacturing aspects of design.
3. Review of stress calculation in various situation - axial, bending, torsion loads and combined effect, example - shaft design. Design for fatigue life, cumulative fatigue damage. Buckling analysis.
4. Design of pin-joints, screw joints, bolted joints, riveted joints, welded joints, transmission screws.

## ME/EE/S/221 ELECTRICAL TECHNOLOGY LABORATORY-II

To supplement the course on 'Electrical Technology- II'.

## ME/S/222 FLUID MECHANICS LABORATORY

Study of different methods of measurement of pressure, velocity and discharge including calibration of selected measuring instruments.
Study of flow visualisation technique: study of characteristics of laminar and turbulent flow.
Verification of Stokes law.
Study of cavitation phenomenon.
Determination of loss through pipes and fittings.
Study of characteristics of hydraulic jump.
Study of subsonic wind tunnel technique – study of growth of boundary layer.

## ME/S/223 APPLIED MECHANICS LABORATORY-I

Simple experiments on Mechanics and Strength of Materials – moment of inertia of a flywheel, spring testing, tension, bending tests, hardness tests, impact tests etc.

## ME/S/224 NUMERICAL ANALYSIS AND COMPUTER PROGRAMMING

1. Introduction to modern digital computers: organisation of digital computer – hardware and software.
2. Concepts of systems.
Flow charts and their use.
3. High level arithmetic languages: FORTRAN programming, statement, numerical input/output; transfer of control; do loops, array, subscripted variable, functions and sub routines, character variables, logical variables and operators.
4. Numerical Analysis:

a. Solution of polynomial equation and simultaneous non-linear equations using iterative terchniques.
b. Solution of simultaneous algebraic equations using Gauss elimination method and various iterative methods.
c. Numerical differentiation and integration using various rules and formulae.
d. Numerical solution of differential equations using various methods like Runge Kutta method, Taylor series method, Predictor-Corrector method etc.
5. Application of numerical analysis and computer programming to solve simple engineering problems.